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ABSTRACT

A total of 102 Spanish-speaking and 104 English-speaking preschool 4-year-old pupils were individually administered the Spanish and English versions of the Cooperative Preschool Inventory (CPI) to examine item responses for possible bias. Miminum logit chi-square regression was applied to each of the 30 items of the CPI verbal scale. Each of the verbal items was cross-classified by response (correct, incorrect), verbal achievement (low, middle, high), and language proficiency (monolingual Spanish or monolingual English). A total of four items exhibited a significant chi-square for language proficiency in the model. In each case, the English speaking students' probability of a correct response was higher than the Spanish-speaking students. The only item displaying an achievement by language proficiency interaction effect was the question, "If you wanted to find a lion, where would you look?" Spanish-speaking children of low achievement had a higher probability (24%) of answering this item correctly than low achieving English-speaking children (4%). To know if these differences are, indeed, more than just potential bias would require follow-up interviews and further examination of the items. Future research may help to verify if there is bias in the items of the Cooperative Preschool Inventory. Tables and figures are included. (NEC)

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AN EXAMINATION OF POSSIBLE ITEM BIAS IN THE RESPONSES OF SPANISH-SPEAKING AND ENGLISH-SPEAKING CHILDREN ON THE COOPERATIVE PRESCHOOL INVENTORY USING LOGIT REGRESSION

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Abstract

A total of 102 Spanish-speaking preschool four-year-old pupils and 104 English-speaking four-year-old pupils were individually administered the Spanish and English versions of the Cooperative Preschool Inventory (CPI). Minimum logit chi-square regression was applied to each of the 30 items of the verbal scale of the CPI. Several differences in the items of the Spanish and English versions of the CPI are noted.

The fidelity of translations of psychological scales has been a concern of researchers. High quality translations allow the examination of psychological constructs in different cultures and in groups speaking different languages. Hulin, Drasgow, and Parsons (1983) summarized four types of translations: (a) accurately in the target language, (b) the aesthetic-poetic translations where the primary purpose is to evoke moods, feelings, and affect in the target language, (c) the ethnographic translation in which a major aim is to maintain the cultural content of the source language, and (d) the linguistic translation which is concerned with the equivalence of meanings of both morphemes and grammatical forms of the two languages. The purpose of this study was to examine the item responses to Spanish-speaking and English-speaking preschool children on the verbal scale of the Cooperative Preschool Inventory (Caldwell, 1970, 1974) to determine if there was potential item bias in the test.

In addition to examining items for possible bias, this study utilized logit regression as the statistical procedure. Logit regression may be used to analyze contingency tables and to use a dichotomous response, converted to a continuous scale, as the dependent variable. The independent variables may be measured on a nominal, ordinal, or interval scale. Such flexibility provides logit regression an advantage over contingency table analysis.

[1]The authors appreciate the comments of Patricia B. Jones, Division of Educational Foundations, University of Arizona, on an earlier version of this paper.

METHOD

Subjects

The study consisted of two independent samples of preschool four-year-old pupils enrolled in the same remedial education program in the fall of 1982, 1983, and 1984 in a large, urban school district in the Southwest. The first sample consisted of 102 Spanish-speaking pupils (42 boys and 60 girls). The ethnic background of this sample comprised 1 Black, 2 Native American, and 99 Hispanic children. The second sample consisted of 104 English-speaking pupils (44 boys and 60 girls). The ethnic background of the second sample was 15 Black, 10 Native American, 1 Asian, and 78 Hispanic children.

Instrument

The English CPI (Caldwell, 1970) is an individually administered English language inventory of school-readiness. A Spanish translation of the CPI (Caldwell, 1974) is used in many programs to assess the school readiness of Hispanic pupils. Although the CPI was published over a decade ago, it is currently marketed. The Spanish translation may be called a pragmatic translation since the primary purpose of the translation is to communicate accurately in the target language. The Spanish version of the CPI is a direct, literal translation of the English which is administered individually by a Spanish-speaking examiner. The CPI is administered in about 15 minutes and pupil responses are scored as correct or incorrect. The CPI consists of 64 items which are grouped into two subscales: (a) a verbal scale of 33 items, and (b) a motor scale of 35 items. Four items of the CPI are considered part of both the verbal

and motor subscales. This instrument is designed to be a brief assessment and screening procedure for individual use with children in the age range from three to six years. It is employed variously as a screening device, a school-readiness measure, an achievement test, and an evaluation instrument. Many school districts use the CPI to identify those individuals unprepared for traditional programs.

Previous research has supported the reliability and validity of the CPI. Powers and Medina (1984) reported alpha reliability estimates of .92 for the English CPI and .90 for the Spanish CPI. In a later study, Powers and Medina (in press) reported that the factor structure of the inventory for Spanish and English versions were similar.

Logit Regression

Minimum logit chi-square regression was proposed by Berkson (1944, 1953) as an alternative to maximum likelihood estimation of regression coefficients in the case of the logistic response model (Duncan 1978). Discussions of logit regression may be found in Snedecor and Cochran (1967), Theil (1970), and Hanushek and Jackson (1977).

For a dichotomously scored variable y which is related to a vector of variables x, the probability that y = 1 is given by the logistic function

$$P(Y = 1) = \frac{1}{1 + e^{-(\alpha+\beta x)}}$$

then $P(Y = 0) = Q = 1 - P$

In order to estimate the parameters α and β of the equation, one may take

$$\text{logit } P = \ln \frac{P}{Q} = \alpha + \beta x$$

where

P = population proportion of Y = 1 responses

α = the population intercept of the regression line

β = the vector of true slopes of the straight line

It is assumed that the xs are observations, p is the observed value of P, which is a random binomial variable distributed around the true P at x with variance = PQ/n. Berkson (1944) showed that the method of least squares could be used to estimate the parameters of the logistic function. Berkson obtained a minimum logit chi-square estimate based on minimization of the following algorithm:

$$\chi^2_{(\text{logit})} = \Sigma npq(l-\hat{l})^2$$

where

n = number of subjects at x

p = 1-q = the observed proportion

l = ln(p/q) = the observed logit

$\hat{l}$ = ln(p/q) = a+bx = the estimated value of the logit

where

$$\hat{p} = \frac{1}{1 + e^{-(\alpha+\beta x)}}$$

$$\hat{q} = 1-\hat{p}$$

The purpose, then, is to obtain a weighted least squares solution of the straight line $\hat{l} = a + bx$ because the logit transformation is intrinsically heteroskedastic violating an important assumption of ordinary least squares. In the case of heteroskedasticity, OLS does create unbiased β although the V (β) is biased.

Hanushek and Jackson (1977) described the application of minimum logit chi-square regression to a contingency table and Duncan (1978) showed how logit regression could be implemented with SPSS. "The log of the odds transformation converts the probability estimates to a continuous unbounded variable which becomes the dependent variable in a linear model with the category definitions as explanatory variables." (Hanushek and Jackson, 1977, p. 191). Logit regression is appropriate where the dichotomous response is regressed on any combination of categorical independent variables and interval-level independent variables. If the interval independent variable were instead a categorical variable, then some method of multiway contingency table analysis would be appropriate. With logit regression, main and interaction effects on responses can be explored with both nominal, ordinal, and interval independent variables.

Procedure

Pupils entering the preschool program were tested individually in October 1982, 1983, and 1984 with the Spanish or English CPI. These language versions were administered approximately one month after the beginning of school so that the child would become accustomed to the new surroundings and to the teacher. Further, the teacher was able to observe the students' language

production in a natural setting and to determine the child's predominant language.

Students were categorized as monolingual Spanish or monolingual English based on teacher observation of students' language production. Students identified as bilinguals were excluded from this study. The total score of the CPI verbal scale was used to place students in three ordered categories of 1) low achieving (1-20), 2) middle achieving (21-40), and 3) high achieving (41-64). Response x achievement x language crosstabulation tables were prepared for each item of the CPI Verbal Scale. The crosstabulation tables were entered into the SPSS regression program following the procedures in Duncan (1978).

Pupils in this study were from lower socioeconomic levels. Eligibility for this educational preschool program which focused on raising reading, language arts, and mathematics skills included the following criteria for participation: (a) the child must be the sibling of an older educationally disadvantaged child, (b) at least one parent of the child lacks a high school education, (c) the child participates in a free lunch program, and (d) the child has limited proficiency in English. Therefore, the possible confounding variable of socioeconomic status was somewhat controlled.

RESULTS AND DISCUSSION

Each of the verbal items was cross-classified by response (correct, incorrect), verbal achievement (low, middle, high), and language proficiency (monolingual Spanish, monolingual English). Language proficiency (monolingual Spanish or monolingual English) of the child was recorded by the classroom

teacher after the observation of the child for a month in the preschool program and an examination of school records.

Frequencies of correct and incorrect responses of a 3 (achievement) x 2 (language proficiency) table were entered into an SPSS regression program with the natural logarithm of the ratio of correct response to incorrect response (log of odds, or logit) as the dependent variable. An achievement by proficiency interaction term was computed which, along with achievement and proficiency variables, was entered as a predictor variable in the regression equation. A full model was estimated and logit chi-sqaure values were calculated from the standard SPSS output using procedures described by Duncan (1978).

A chi-square test of the effect of achievement on the probability of a correct response was computed for each item. A significant chi-square would indicate a difference in the probability of a correct response for individuals at different achievement levels. Another chi-square test of the effect of language proficiency on the probability of a correct response was computed for each item. This significant chi-square would be interpreted as the effect of language proficiency on the probability of a correct response. A chi-square test of the effects of the interaction of achievement and language on the probability of a correct response was also computed. A significant chi-square would indicate a differential effect on the probability of a correct response as a function of achievement level and language proficiency.

Typical results of item chi-squares are given in Figures 1 and 2. An example of an item exhibiting a significant chi-square of the effects of achievement on the probability of a correct response is presented in Figure 1. In

this example, neither the chi-square test for language proficiency nor the chi-square test for interaction was significant. A substantive interpretation of a significant chi-square of achievement would be that the probability of a correct response increases with verbal ability. Figure 1 also displays the observed logits and the least squares regression line. Figure 2 shows an item with significant chi-square for interaction. From this graph, it is clear that the probability of a correct reponse for low achieving Spanish-speaking students exceeded that of low achieving English-speaking students. High achieving English-speaking students had a higher probability of answering this item correctly than did the high ability Spanish-speaking student.

A total of 27 items revealed significant chi-square tests of the effects of achievement on probability of a correct response. In each case, the probability of a correct response increased with verbal achievement levels as would be expected. Items without a significant chi-square for achievement were 1, 24, 28, 36, 38 and 40. The reason item 1 did not have a significant chi-square fro achievement was that it was an easy item students at each achievement level generally answered it correctly. Refer to Table 1 for a listing of all the verbal items of the CPI and chi-square values.

A total of four items (2, 19, 21, 24) exhibited a significant chi-square for language proficiency in the model. In each case the English speaking students probability of a correct response was higher than the Spanish-speaking students.

2. How old are you? ¿Cuántos años tienes?

19. If you were sick who would you go to? ¿Si estás enfermo, a quién vas a ver?

21. If you wanted to buy some gas where would you go? ¿Si quieres comprar gasolina, a dónde vas?

24. If you wanted to find a lion, where would you look? ¿Si quieres hallar (encountrar) un leon, dónde lo buscas. (Caldwell 1970, p. 4-7; 1974, p. 4-8)

The only item displaying an achievement by language proficiency interaction effect was items 24. This item is presented in Table 2 as the percentage of children within each cell of the achievement by language proficiency matrix. Item 24 was "If you wanted to find a lion where would you look?" (Caldwell, 1970, p. 7)or Si quieres hallar (encontrar) un leon, donde lo buscas?)(Caldwell, 1974, p. 8). Spanish-speaking children of low achievement had a higher probability (24%) of answering this item correctly than low achieving English-speaking children (4%) and high achieving English-speaking children (96%) appeared to have known this item better than high ability Spanish-speaking children (43%).

To know if these differences are, indeed, more than just potential bias would require follow-up interviews and further examination of the items. Future research may help to verify if there is bias in the items of the Cooperative Preschool Inventory.

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Table 1

Chi-square Tests of Independence for Achievement (Ach), Language Proficiency (Pro) and Interaction (Int) for each Verbal Item of the Cooperative Preschool Inventory.

Item	Chi-square		
	Ach	Pro	Int
1	.03	1.35	.25
2	15.46***	4.76*	.90
3	10.00**	.01	.31
6	11.45***	.88	.48
7	13.08***	2.07	.45
8	10.58**	1.17	2.73
19	10.35**	4.59*	.62
20	6.53*	.27	.14
21	15.13***	6.61**	3.20
22	9.78*	.00	.03
23	11.77***	.02	.72
24	.51	11.23***	14.23***
25	27.40***	.36	2.72
26	13.49***	.02	.09
27	17.36***	.54	2.22
28	2.80	.00	.33
29	35.05***	.17	1.42
30	5.17*	.10	.26
31	11.83***	2.00	.76
32	24.67***	3.34	1.69
33	23.14***	.62	2.65
34	11.74***	.00	.42
35	10.88****	.04	.03
36	.23	2.87	3.44
37	14.73***	1.45	1.82
38	1.54	.04	.02
39	12.09***	.09	.55
40	.91	.51	1.04
41	20.40****	.73	.23
48	8.02**	.33	1.40
56	20.31***	.02	.03
57	11.63***	2.56	.41
58	6.24*	.07	.13

Note. *$X^2(1) = 3.84$, $p < .05$.
**$X^2(1) = 6.64$, $p < .01$.
***$X^2(1) = 10.83$, $p < .001$.

Table 2

Percentages of Correct Responses within Cells of Achievement x Language Categories of Item 24 with Significant Interaction.

Item	Language	Low	Middle	High	Chi-sqaure
24	E	4%	45%	96%	14.23***
	S	27%	29%	43%	

Note. E = Monolingual English group, S = Monolingual Spanish group.

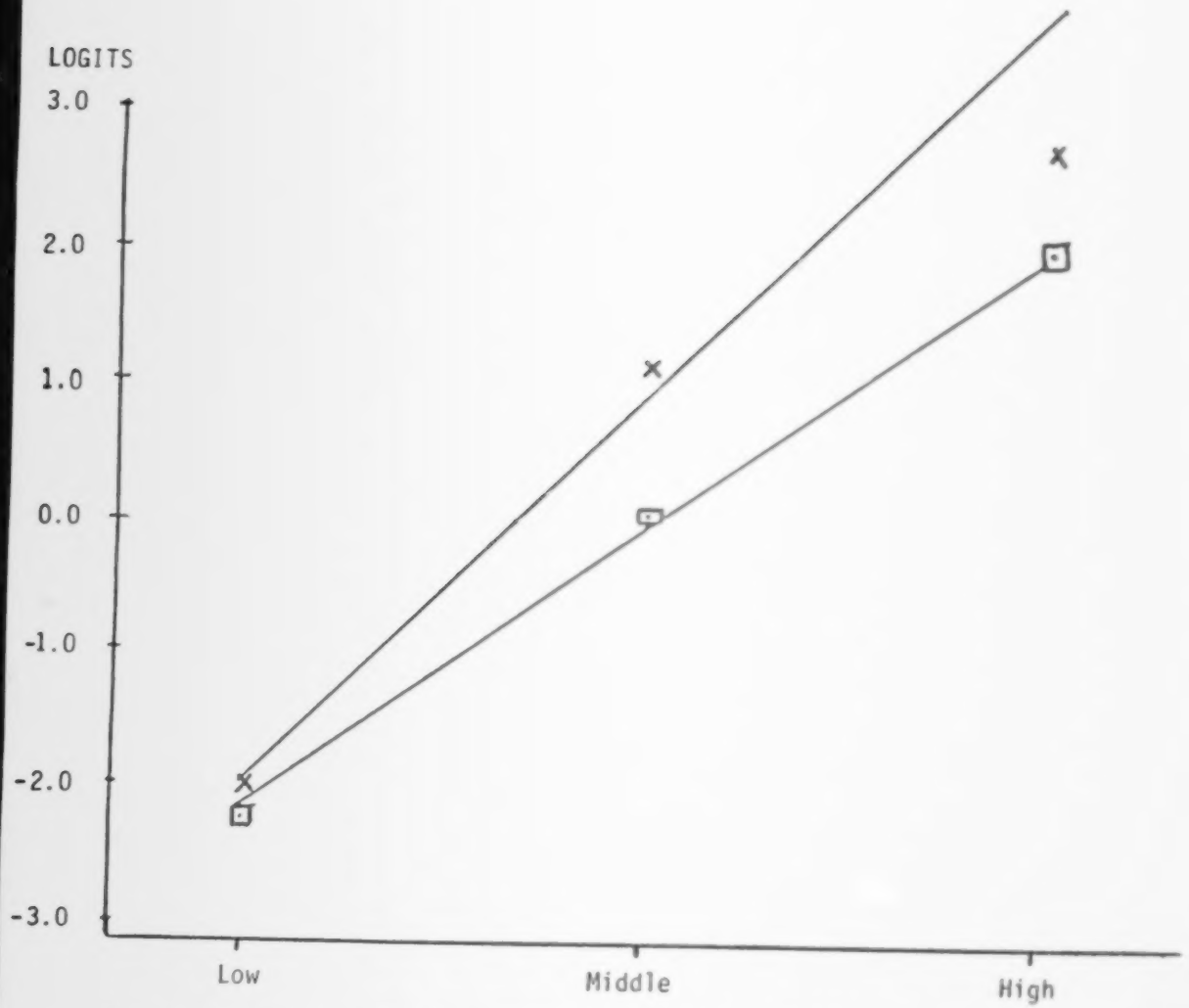

Figure 1. Regression of Response of Item 29 on Achievement by Language Proficiency.
Legend x = Monolingual Spanish
⊡ = Monolingual English

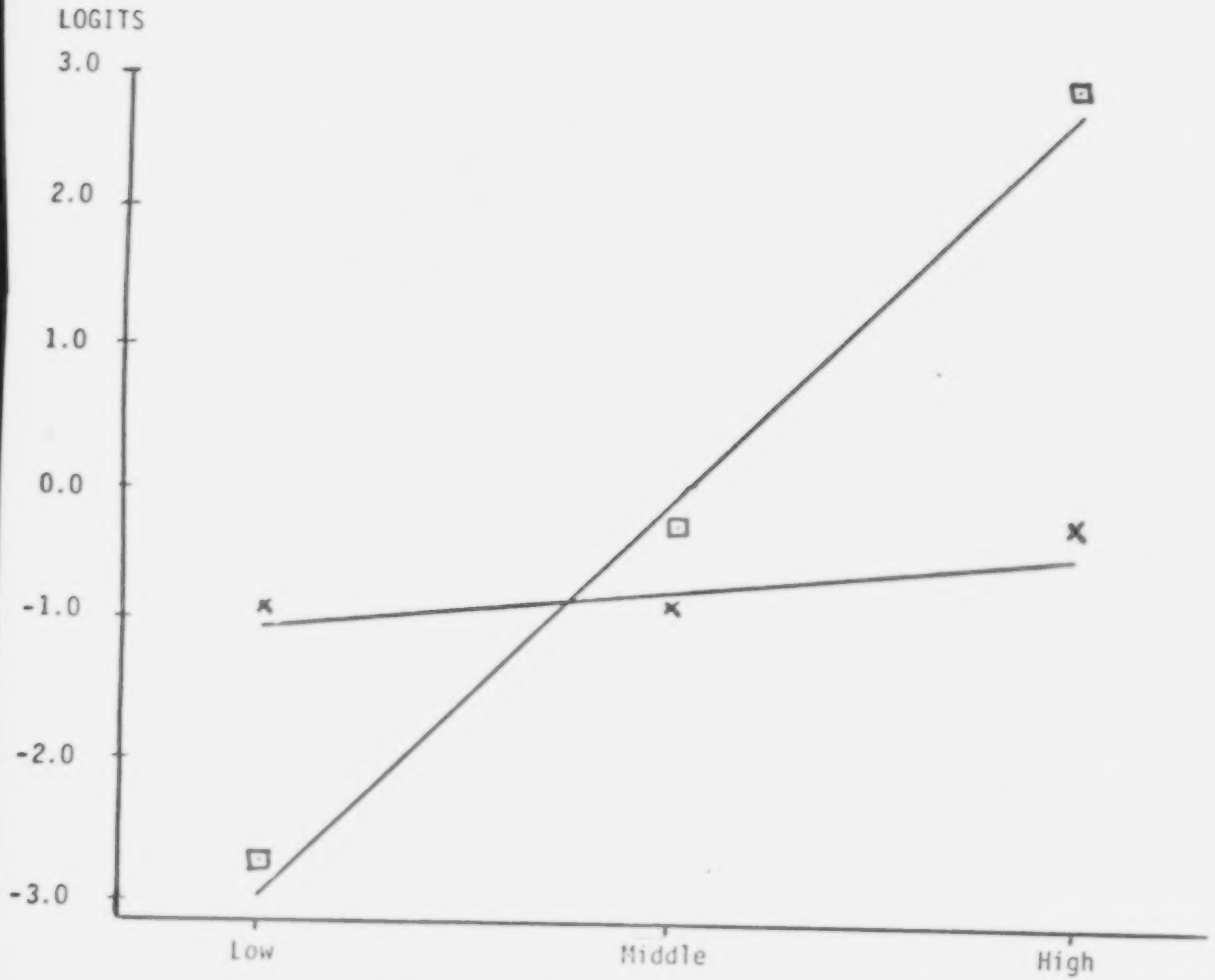

Figure 2. Regression of Response of Item 24 on Achievement by Language Proficiency.
Legend x = Monolingual English
□ = Monolingual Spanish

APPENDIX A

SPSS Program Cards from Duncan's (1978) Procedure for Calculating Minimum Logit Chi-square Regression as applied to one item of this study.

```
VARIABLE LIST          X1, X2, A, B
INPUT MEDIUM           CARD
INPUT FORMAT           FIXED (4F2.0)
N OF CASES             6
COMPUTE                Y = LN ((A+.5)/(B+.5))
COMPUTE                WT = (A+.5)*(B+.5)/(A+B+1)
COMPUTE                X1X2 = X1*X2
WEIGHT                 WT
REGRESSION             VARIABLES = Y, X1, X2, X1X2
                       REGRESSION = Y WITH X1, X2, X1X2(3)
READ INPUT DATA
FINISH
```

Note. With all three variables entered in the multiple regression equation, the chi-square values are obtained by multiplying the F value for each variable by the residual mean square.

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